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***The CGIAR Research Programs:  
Gearing Up for New Challenges***

**Strengthening CGIAR—Private Sector  
Partnerships In Biotechnology:**

**A Private Sector Committee Perspective on Compelling Issues**

Please find attached a paper by the Private Sector Committee reflecting the Committee's views on ways of strengthening CGIAR—private sector partnerships in biotechnology. This paper is background for discussion of Agenda Item 5 (Biotechnology in the CGIAR) and Item 7 (Positioning the CGIAR in the Global System).



Consultative Group on International Agricultural Research - CGIAR  
Private Sector Committee

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Dr. Ismail Serageldin  
CGIAR Chairman  
The World Bank  
1818 H Street, N.W.  
Washington, D.C. 20433

Einbeck, April 30, 1997

Dear Ismail:

It gives me pleasure to forward you a paper reflecting the Private Sector Committee's views on ways of strengthening CGIAR - private sector partnerships in biotechnology. We offer this as the first of what we hope to be a series of notes reflecting our viewpoints on different aspects of partnerships between the CGIAR and the private sector.

We note that there is a significant vacuum in biotechnology-based research directed towards problems of developing countries. The CGIAR can play an important role in filling this void. However, this should not be at the expense of the CGIAR's existing comparative advantage, which is based on its knowledge of agricultural systems, experience in applied research, networks of contacts in developing countries, and germplasm collections. The CGIAR could be a more attractive partner to the private sector if it builds on these advantages, makes the private sector more aware of its specific strengths, and expands its capacity in biotechnology.

Our Committee will meet on May 25, 1997 in Cairo to discuss the follow-up of the views expressed in the paper, including our support to you in the organization of a High-Level Conference of private sector leaders. We also plan to participate in the various discussions on biotechnology during the CGIAR Mid-Term Meeting.

I would like to acknowledge the significant help we received from the Secretariat in the preparation of this paper, including collection and analysis of relevant information and editing successive drafts in consultation with Committee members.

I hope our analysis and views are helpful to the CGIAR as they examine its future course. I look forward to discussing these aspects with you in Cairo.

Sincerely,

- Andreas J. Büchting -  
Co-Chair, PSC

cc.: Alejandro Rodriguez Graue, PSC Co-Chair

# **Strengthening CGIAR—Private Sector Partnerships In Biotechnology:**

**A Private Sector Committee Perspective on Compelling Issues**

CGIAR Private Sector Committee

April 30, 1997

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## Summary

The private sector has become a dominant actor in agricultural research—particularly in the area of agricultural biotechnology—because it is estimated that the market for genetically engineered crops will become a \$20 billion per year business by the year 2010. In the United States alone, the private sector spends probably 20-30 times what is spent on agro-biotechnology research geared toward developing countries.

Two issues are critical to discussion about public-private partnerships in biotechnology: (1) intellectual property protection of enabling technologies and (2) shifting boundaries between public and private sector research. Regarding the *first*, as research in agricultural biotechnology expands globally, so, too, will the number of new proprietary technologies, which will create further barriers to the smaller players' *freedom to operate*. Unless special partnership arrangements with the private sector are established, the CGIAR and its partner public research institutions will not have access to the enabling technologies controlled by the private sector that are significant for addressing the problems of developing countries. Regarding the *second*, in developing countries, the market segments of greatest interest to the private sector are those where the private sector can capture value. Research on other market segments, such as subsistence farming in resource-poor areas, must be conducted by the CGIAR and other public research institutions. As the public-private sector boundaries in research change, public research institutions will need to realign their strategies.

There is a compelling case for the CGIAR to strengthen its capacity in biotechnology. A CGIAR with a stronger biotechnology capacity would: (1) be better connected to the cutting edge research in biotechnology; (2) have easier access to and stronger absorptive capacity to use proprietary private sector technology; (3) build intellectual assets that could enable it to participate more effectively in the changing global biotechnology market; and (4) in general, help expand the developing world's *freedom to operate*. An increased role in biotechnology, however, would compel the CGIAR to reconcile the public good nature of its work with the norms prevailing in the biotechnology industry, such as patenting and licensing.

While strengthening its biotechnology capacity, the CGIAR should not weaken its existing strengths. Biotechnology should be treated as one of the tools Center researchers can use in conjunction with other powerful tools in developing agricultural technologies needed in poor countries. Also, in strengthening its biotechnology capacity the CGIAR should avoid "re-inventing the wheel" and aim to access enabling technologies that are available elsewhere. This will require the CGIAR to expand significantly its "technology scouting" effort. Successful biotechnology firms invest not only in their internal research capacity, but also in connecting to networks of learning.

Private companies could assist the CGIAR in this area in several ways—ranging from staff and information exchanges to collaboration on specific projects. But for these alliances to take shape it is important that the two partners know at the start what they each would gain from the partnership. This may require building incentives to make partnerships with the CGIAR attractive to the private sector.

It is equally important to raise the awareness of private sector leaders about the CGIAR and its potential as a research partner. It would be useful to organize a high-level conference of private sector leaders to familiarize them with the CGIAR and seek their advice on developing public-private partnerships to develop technologies targeted toward orphan market segments in developing countries. The CGIAR Private Sector Committee (PSC) is prepared to assist in organizing such a conference.

# **Strengthening CGIAR–Private Sector Partnerships in Biotechnology**

## **A Private Sector Committee Perspective On Compelling Issues\***

### **Introduction: The Need for Stronger Partnerships**

The need to strengthen the research partnerships of the Consultative Group on International Agricultural Research (CGIAR) with the private sector has become more urgent as the result of three recent developments. First is the increasing realization that advances in technology are key to overcoming the global problems of poverty, hunger, and environmental degradation in developing countries. Second, the private sector is now a major actor in global agricultural research, largely because of its increasing involvement in biotechnology. Third, within the public agricultural research sector there is increased focus on creating public-private partnerships, at the national, regional, and global levels, to address the problems in developing countries.

The private sector has become a dominant actor in agricultural research, particularly in the area of agricultural biotechnology. It is estimated that the private sector is responsible for approximately 80 percent of research in plant biotechnology worldwide.<sup>1</sup> In the United States alone, the private sector spent US\$595 million on agricultural biotechnology research in 1992.<sup>2</sup>

The private sector's interest and participation in agricultural biotechnology research has increased because of the expanding market opportunities throughout the value chain, from agricultural inputs to consumer goods. An indication of the value in these markets is that U.S. farmers alone purchase US\$3.5 billion of planting seed per year.<sup>3</sup> Companies are experimenting with different ways to capture value from their investments in biotechnology because the market potential of genetically engineered crops is high. It is expected to be \$2 billion per year worldwide by the year 2000, \$6 billion by 2005, and \$20 billion by 2010.<sup>4</sup>

The private sector's large investment in biotechnology has made it a major player in the "basic" research end of the "basic-strategic-applied-adaptive research" continuum. This contrasts with the private sector's traditional role as the user of the basic and strategic research findings of public sector institutions.

The first transgenic plants were sold in the United States in 1996. Their commercial success solidified the strategic direction of the private sector. (See Annex 1 for an excerpt from the *Harvard Business Review* about the recent experiences of a major U.S. company.)

While agricultural biotechnology firms were concerned with approval of their regulatory

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\*Prepared by Selçuk Özgediz (CGIAR Secretariat) on behalf of the CGIAR Private Sector Committee (PSC). The PSC discussed an earlier draft at its meeting in London on April 1–2, 1997. Comments by PSC members and by Joel Cohen, Peter Gregory, Guido Gryseels, Robert Horsch, Manuel Lantin, David MacKenzie, Deborah Merrill-Sands, Alexander von der Osten, Michel Petit, Ralph Riley, Suri Sehgal, Frauke Spanakakis, and Don Winkelmann are gratefully acknowledged, as are research assistance provided by Donna Podems (consultant) and secretarial assistance by Timni Mahase (CGIAR Secretariat).

submissions on transgenic plants in the early 1990s, the CGIAR and its partners were assessing how science could be used more effectively to address the developmental and environmental challenges faced by developing countries. This was the major theme of the CGIAR's Renewal Program, which, after a careful review of issues, redefined in 1995 the CGIAR system's mission as *"contributing through research to sustainable agriculture for food security in developing countries"* and outlined a research agenda to help accomplish this mission. A major emphasis of the Renewal Program—to strengthen global and regional research partnerships—was sparked by a number of factors, including the following:

- Declining public resources devoted to research (both real expenditure per researcher and the annual growth rate in research expenditure)
- The trend toward globalization and its consequences on reduced barriers toward cooperation and interdependence
- Advances in information technology, making communication across the globe faster and less costly.

This paper reflects the views of the CGIAR Private Sector Committee (PSC) on issues that have a strong bearing on public-private sector research partnerships. It focuses on biotechnology because of the promise it holds for generating quantum leaps in agricultural production. Biotechnology alone, however, cannot solve the problems associated with agricultural development in developing countries. Additional technologies (e.g., improved seed, fertilizer, and crop management techniques) are needed to address key bottlenecks that currently limit agricultural production.

The opportunities for CGIAR-private sector partnerships are not limited to the area of biotechnology. The private sector is involved in research on all stages of agricultural production and delivery, including agricultural inputs, production technologies and processes, and agricultural marketing. In the United States agricultural research spending by the private sector in non-biotechnology areas exceeded research spending on agricultural biotechnology by a ratio of more than four to one.<sup>5</sup> The PSC will continue to examine the potential for partnerships in these other areas and will advise the CGIAR of possibilities for strengthened collaboration with the private sector.

### **Compelling Issues**

Three issues are critical to the discussion of public-private partnerships in biotechnology:

- Intellectual property protection (IPP);
- Ensuring biosafety
- Market segments and shifting boundaries between the public and private sectors.

The key issue for the CGIAR is to determine how it can expand its access to the technologies needed to generate improvements in the tropical and orphan commodities that are important to poor people in developing countries.<sup>6</sup>

## **Intellectual Property Protection**

The current discussion about public-private research partnerships centers around two issues: technology ownership and technology development.

**Technology ownership.** Two distinct technologies are used to generate transgenic seeds: (1) technology to create the genes that encode the proteins responsible for the (transgenic) trait, and (2) technologies related to the techniques for inserting, identifying, or manipulating the genes in cells through plant transformation systems, selectable markers, and gene expression techniques. Both technologies are needed to produce transgenic plants.

Recent developments in the management of plant biotechnology in industrialized countries, particularly in the United States, illustrate the technology ownership and valuation issues that have emerged. These include the following:

- Research by firms to confer specific traits to plants and the subsequent patenting of the results of the new technology
- Valuation, and separate pricing, of the new trait, distinct from the value of the seed (or “vehicle”) that carries the trait
- Emergence of a “trait market” for technologies at the molecular level, enabling the bundling of several traits into a germplasm.

While they are not of immediate relevance to developing countries, such developments indicate the types of issues that developing countries could face as their IPP regimes mature. These developments also indicate issues that are important to the private sector when considering partnerships with developing country institutions and the international Centers. These issues include the following:

- Developing countries with strong IPP regimes, regulatory environments, and private sector are of interest to the private sector in the North because there is potential to capture value from investments. Such countries would benefit from new technology sooner and enter the global biotechnology market sooner than other countries.
- The Centers, because of their strong ties with developing country institutions, could play an important intermediary role in establishing or strengthening IPP regimes in developing countries. This could be achieved by providing Center-coordinated biotechnology networks, advice to developing countries on regulation and biosafety issues, and “honest broker” activities for linking companies with markets. Stronger IPP regimes are in the long-term interest of both the local and international private sectors.
- If a global “trait market” evolves, developing countries and the Centers will be able to participate in this market more effectively if they have a cache of “trading chips” in the form of traits generated through their own research.

**Technology development.** Modern plant breeding, in combination with the use of biotechnology, has led to complex forms of IPP. As a result, the entire breeding sector is confronted with an expanding variety of different protective rights. For example, a transgenic insect-tolerant plant can involve plant breeders’ rights and plant patents as well as patents related



to transformation technology, the selectable marker used, the gene coding for the insecticidal protein, the promoter, and the various regulatory elements and modifications needed to express genes adequately in plant cells.<sup>7</sup>

The string of protections associated with a germplasm is leading to the emergence of a complex set of intellectual property rights claims (IPR pedigree) and imposition of legal barriers that limit the researchers' *freedom to operate*. "Any IPR holder of even one element could block the commercialization of an insect-tolerant variety based on this [such as the example presented above] package of technologies...Freedom to operate will become even more complicated as companies seek to bundle traits to gain competitive advantage. A second generation of transgenic crops are likely to contain both input traits, such as insect resistance and herbicide tolerance, and output traits like altered oil and protein quality."<sup>8</sup> The complexity of such rights is a major reason for the realignments that took place within the biotechnology industry in recent years in the form of mergers or acquisitions among large corporations.

As research in agricultural biotechnology expands globally, the number of new technologies generated (and the associated proprietary rights) will increase, creating further barriers to the *freedom to operate* of the smaller players (e.g., the CGIAR and most of the public and private research organizations in developing countries). The large companies, with a large number of technologies, will be the least affected because they can trade with third parties in the "trait" market from a position of strength.

In such a situation, unless special arrangements are made, the public sector will have no access to the enabling technologies that are controlled by the private sector and that are so important for addressing the problems of tropical crops in the CGIAR's domain. Thus, a major reason in favor of potential partnerships between the CGIAR and the private sector is to gain access to private sector technologies for noncompetitive use in developing countries. For the private sector to be interested in such partnerships there has to be sufficient incentives.

While biotechnology is becoming more visible as a tool in technology development, one should not lose sight of the fact that it is one of many tools plant scientists use to generate new or improved products. Plant breeding, one of the areas in which the CGIAR has been traditionally strong, will continue to be important, as will the various techniques of crop management.

## **Ensuring Biosafety**

A bioengineered product has genes from several varieties of the same crop, but it introduces no more risk to the environment than a similar product generated through traditional means. When biotechnology is used to transfer a gene from a different crop species, bacteria, or animal to a crop variety, however, the public raises questions about the safety of the new variety with regard to people and the environment. Questions arise because of the uncertainties about how the new variety will affect an ecosystem and how its interactions and behavior will change over time.

These questions are addressed at two levels. First, through self-accountability by the biotechnology companies and their scientists according to corporate and professional ethics that protect the interest of the public. A company knows full well that its reputation is at stake every time it markets a new product. Second, through biosafety regulations of the country.

Regulatory systems differ from country to country. In the United States, the Food and Drug

Administration (FDA) has determined that “plant foods produced through biotechnology present no inherent risk and, therefore, should be regulated as any other food entering the marketplace....FDA uses the characteristics of the food, not the processes used in its production, as the basis for regulating food products derived through biotechnology.”<sup>9</sup> In contrast, European Union countries pay much more attention to the processes used in the production of transgenic products because of concerns raised by environmental groups. Developing countries are only beginning to introduce legislation on biosafety matters.

Because of their international and scientific nature, the Centers can effectively promote biosafety in developing countries. Through their own practices, they can serve as examples and through their participation in biotechnology networks they can help strengthen developing country capacities in this area.

The international field-testing networks coordinated by the Centers are global assets that could be used to field-test transgenic crops under tropical conditions, with full attention to biosafety. This is another prime area for potential collaboration between agricultural biotechnology research firms and the Centers.

### **Public-Private Boundaries and Orphan Market Segments**

The vast majority of the world’s ex situ plant germplasm (3.8 million stored seedsamples) is held by the public sector—mainly governments and the international Centers. Although the Centers hold only 14 percent of these seed samples, “this amounts to roughly 40 percent of the unique food-crop germplasm in living collections.”<sup>10</sup> The elite breeding material of the IARCs on tropical and orphan crops is of particular global importance. In contrast, in developed countries, most of the important elite breeding material is held by private companies.

The private sector’s involvement with agricultural biotechnology varies with the crop. Companies invest in biotechnology research for crops and market segments where it is possible to capture value. Thus, the temperate crops, which are more important in industrial countries, have received more attention than tropical crops, which are of greater importance in developing countries.

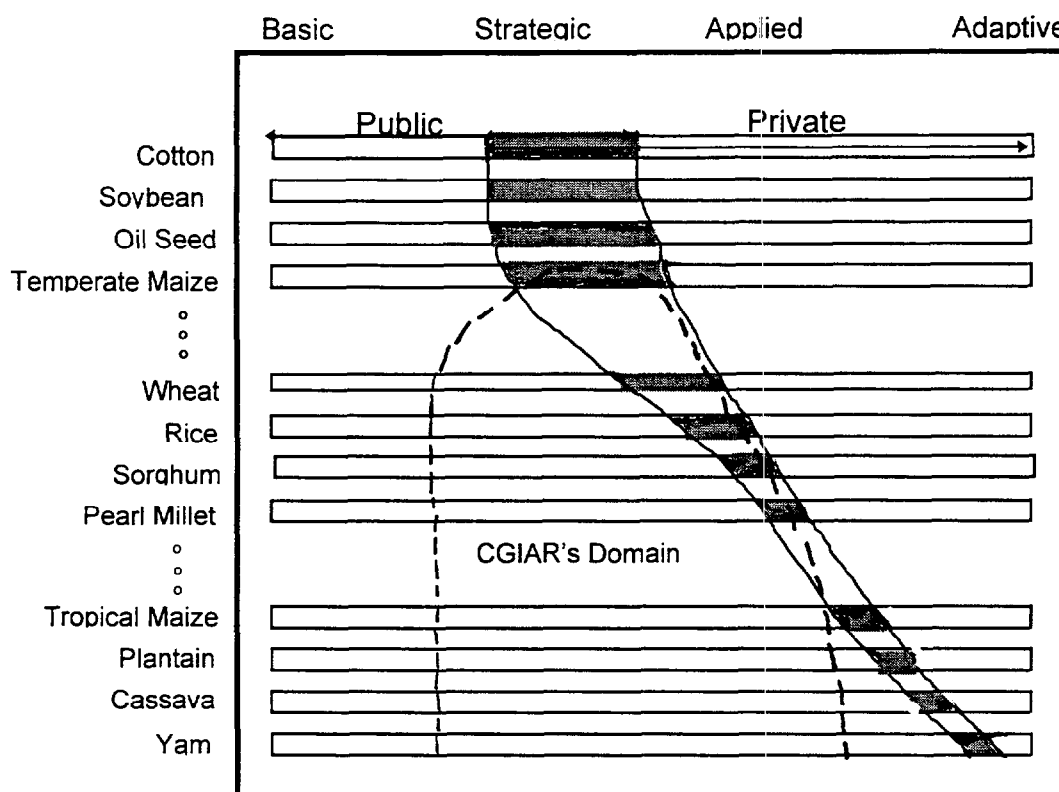
In industrial countries, the private sector’s entry into research on specific commodities has not been accompanied by a corresponding scaling down of public sector research activities on the same crops. As a result, for some crops there is overlapping effort between the public sector and the private sector, which is raising questions about the future role of public research institutions.

The situation is quite different for tropical crops, which are the primary focus of developing countries and the CGIAR. In these cases, the private sector has only a limited role in research; most of the strategic and applied research is carried out by the public sector (including the CGIAR).

These two situations are illustrated in Figure 1, which shows the overlap in research effort between the public and private sectors. The horizontal axis shows the types of research on a continuum from basic to adaptive. The left side of the horizontal axis (i.e., basic research) traditionally has been the domain of the public sector because basic research has been and continues to be a public responsibility; the right side of the axis (i.e., adaptive research), which is closest to the marketplace, has been the domain of the private sector. Where these two lines converge is the overlap in research effort, which differs from crop to crop, as indicated by the

vertical axis. The overlaps indicated are illustrative only, as are the crops listed.

**Figure 1. Public - Private Boundaries in Agricultural Research**



The following three key messages emerge from the boundaries illustrated in Figure 1:

- Although the line separating the two domains has been shifting to the left (i.e., there has been increasing involvement by the private sector in strategic research), the speed of the shift is much slower for crops of interest to the CGIAR. This means that for the foreseeable future (i.e., until market conditions in developing countries make it attractive for the private sector to invest heavily in research geared toward crops for tropical environments) the research vacuum that exists must be filled by the CGIAR and its partners.
- There is no uniformity across—or even within—crops. For example, the transgenic maize developed for temperate regions is not suitable for tropical environments because of differences in stresses. However, some aspects of transgenic research on temperate maize would apply to tropical environments and could be a subject of discussion between the CGIAR and the private sector.
- The current focus on biotechnology and the increasing overlap between research efforts by the public and private sectors mask the continuing importance of the public sector's role in research areas that are less based on biotechnology, which include the following:

- Research related to biodiversity, including germplasm conservation
- Research on ecosystems, management of natural resources, and farming practices
- Research on public policy issues.

The private sector is less interested in crops per se than in potential markets and market segments for crops within specific countries. In developing countries, there are various market segments for a specific crop, ranging from resource-rich to resource-poor environments, and from small-scale to large-scale producers. The market segments of greatest interest to the private companies are those where they can capture the most value. These are usually the market segments where the value added to the producer are the greatest, and often they correspond to large-scale farming in resource rich areas.

For a different perspective on public-private sector boundaries, it is useful to identify the *orphan market segments* in the developing world that are not attended to by the private sector. This concept is broader than *orphan crops*, however, as it also includes such crops as rice, wheat, and maize where the level of private sector involvement varies. If the CGIAR's research domain covered all *orphan market segments*, this would complement the involvement of the private sector.

Despite the weakness of regulatory regimes in many developing countries, major international companies are vigorously exploring marketing opportunities in these countries. For example, according to a recent review, European agricultural biotechnology investments in Asia increased from \$220 million in 1993 to \$270 million in 1995. Most of this investment is in the seed sector because Asia has become the world's largest seed consumer in the 1990s.<sup>11</sup> As these investments increase, the private sector is likely to expand its focus from the market segment of large-scale farming in resource-rich environments to include *orphan market segments*. This shift in focus will require the CGIAR and its partners to reexamine their own focus if they are to avoid excessive duplication of effort with the private sector.

## Perspectives on Partnerships

Private sector firms enter into many partnerships. To understand the dynamics of these alliances it is essential to examine the context in which companies operate. For the CGIAR it is also important to understand how partnerships work in the area of biotechnology. This section covers these subjects and reviews strategy options of the private sector and the CGIAR.

### The Private Sector Context

First and foremost, corporations have a *fiduciary responsibility* to their shareholders. Corporations act on behalf of the shareholders and their boards and management are accountable for their actions. The chief interest of the shareholders is return on investment. Corporate actions, therefore, are judged first by their potential impact on shareholder value.

Corporations also operate in a competitive environment, where timing, competitive advantage, and efficiency are key. Many corporate decisions on alliances are dictated by considerations of competitive advantage in a business sector or market. Decisions on long-term investments depend on corporate visions and strategies and also involve building competitive advantage over the long term.

Private corporations also have *public responsibilities*. As members of communities and society, they are frequently engaged in activities that serve the public interest. Such activities contribute positively to a corporation's image, which, in turn, often increase the public appeal of the corporation's products and services. This is often a key argument for balancing accountability to the shareholders with accountability to the public.

Finally, the private sector as a whole is interested in global development, because today's poor countries can be regarded as tomorrow's markets. The sooner incomes rise in the developing world, the sooner there will be opportunities to market products and services in these countries. Additionally, development may be viewed as an aid to global security and thus discourage disruption of global trade and financial markets.

Many large corporations recognize that they have much to contribute to global development. As one corporate executive recently noted, transfer of knowledge could help developing countries leapfrog from pre- to post-industrial age technologies.<sup>12</sup> What the private sector can do to assist this transition will depend on how it is able to balance its accountability to shareholders with its responsibility to the public.

### **Learning Through Partnerships**

Corporations form partnerships mainly for competitive advantage. The reasons could be proactive (to gain a new competitive edge) or reactive (to not lose ground to the competition). The advantage sought is either in the cost structure (greater efficiency) or the revenue base (return on investment). Better information, superior technology, better human resources, wider markets, better control of uncertainty, and similar advantages are expected to lead to cost or revenue advantages and a stronger "bottom line."

Being a good partner is regarded as a key corporate asset (sometimes called a company's *collaborative advantage*) because a well-developed ability to create and sustain fruitful collaborations gives a company a significant competitive edge.<sup>13</sup> A recent review of literature on strategic alliances<sup>14</sup> noted that most partnerships entered into by companies are in the form of licensing arrangements, joint ventures, or consortia. Annex 2 provides a summary of the advantages and disadvantages of these three forms of partnerships.

Successful biotechnology firms are intricately connected to various networks. Having an internal biotechnology research capacity is necessary but not sufficient for innovation. The complexity of the problems faced and the rapidity of the advances in knowledge compel companies and their researchers to reach out widely for partners.

Recent research on the locus of innovation in the U.S. biotechnology sector shows that "when the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than in individual firms."<sup>15</sup> In the area of biotechnology, relevant knowledge is widely distributed and constantly changing. It is difficult to produce this knowledge within a single research institution or to obtain it easily through only a few market transactions. Thus, biotechnology firms expand to ensure that they remain well connected to benefit-rich networks, through both formal and informal ties. There appears to be a *liability of unconnectedness* at work in biotechnology and other fields in which intellectual developments are expanding rapidly.<sup>16</sup>

There are several examples of successful transfer of biotechnology between companies

from industrialized countries and public institutions in developing countries, most of which were facilitated through special international programs.<sup>17</sup> There are also several examples of collaboration between private firms and CGIAR Centers. (Both types are summarized in Annex 4.) Two notable features of these partnerships are that they are ad hoc and that their viability depends on the goodwill of the corporate partner.

These findings and observations have the following implications for the scientific capacity of the CGIAR:

- At a minimum, Centers need the *capacity to access* knowledge and evaluate its potential usefulness for their own or their partners' research.
- Centers need the *capacity to use* knowledge obtained from the outside and build on it for their own purposes.
- The Centers' in-house research capacity in biotechnology is important, but without a strong *cooperative research* dimension this capacity is not likely to lead to rapid learning and innovation.

### Questions of Strategy

CGIAR–private sector research partnerships in biotechnology will become stronger through dialogue as their similarities of interest and purpose expand and as both parties build their collaborative advantage. In this regard the private sector and the CGIAR face a number of strategic choices.

**Questions of strategy for the private sector.** Companies enter into alliances with a partner they are interested in when that partner offers advantages over other potential partners. For biotechnology geared toward developing countries, the private sector can form partnerships with the following three types of organizations:

- Local private companies
- Public sector institutions
- International Centers.

The type of partner preferred depends on the nature of the alliance in terms of its research intensity. When the issue is *how to market a finished product*, a local private company clearly has the edge over the others because in such value chain alliances proximity to the market is the dominant factor.

When the issue is *how to test a close-to-final product*, the choice would be a partner who can do this most efficiently. A public sector partner would be the most attractive if the effort involves a single country; while an international Center might be preferred in multicountry situations (most likely, in partnership with several national public institutions.)

In earlier stages of product development the issue is *who to collaborate with to solve a series of research problems*. In this case, potential partners would be selected based on their competence and their complementary skills and assets. Public sector NARS biotechnology institutes and CGIAR Centers are the two most likely choices for most companies because the local private sector in most developing countries has not yet matured in this area.

In all of the above cases, the private sector companies would be interested in:

- Exclusive arrangements
- Strengthening IPP regimes (for their own long-term interest)
- Development of a dynamic private sector.

**Questions of strategy for the CGIAR.** The CGIAR's comparative advantage lies in its knowledge of tropical agriculture, experience in applied research, networks of contacts in developing countries, germplasm collections, and high-quality research settings. In this respect, the CGIAR has few equals in developing countries.

Two issues are critical for CGIAR's collaborative advantage in the area of biotechnology: (1) its research capacity and (2) its position on protection of intellectual property—in particular, as it relates to access to private sector proprietary technology.

*The CGIAR's capacity in biotechnology.* The CGIAR Centers' capacity in biotechnology is small compared with that of the private sector. According to a PSC survey, the Centers spent about \$22 million in biotechnology in 1995. About \$10 million of the \$22 million was spent by one institute, the ILRI. The remaining \$12 million spent by the other 15 institutes represented less than 5 percent of their total expenditures for 1995.

Including expenditures by the CGIAR Centers, total global investment in agricultural biotechnology research geared toward developing countries is about \$50 million per year. This includes investment by the international technology transfer programs described in Annex 3<sup>8</sup> and the spending by indigenous biotechnology institutes in developing countries (e.g., Brazil, China, India, Indonesia, and Thailand).

The \$50 million per year for developing countries, however, pales in comparison with the approximately \$2 billion per year investment (both the public and private sectors) in agricultural biotechnology research directed toward industrialized countries.<sup>19</sup> While spending for research in industrialized countries far exceeds that for developing countries, the problems that could be addressed through biotechnology for the developing world are at least as significant from the standpoint of global development.

Thus, the question is not *whether* the global community should increase its investment in agricultural biotechnology research geared toward solving problems in developing countries, but rather *by how much*. How much depends on one's vision of how rapidly one should generate impacts on food security and poverty and on one's confidence in the potential of biotechnology. It also depends on the priority of the specific problems that must be addressed. Examples of high-priority biotechnology projects include the following:

- Mapping the genomes of crops of importance to developing countries
- Research on raising the yield of these crops
- Research on addressing biotic and abiotic stresses of tropical environments
- Research on product characteristics (e.g., micronutrient content)
- Making crop production more environmentally friendly.

The CGIAR is in the best position as a research system to lead a major international biotechnology effort to address problems of developing countries. This fits well within the CGIAR's

traditional and continuing role as a bridge between the basic and strategic research institutes in industrialized countries and the research systems of developing countries. Some research problems, such as mapping the cassava genome, need not be worked on separately by several developing countries; rather, they each could contribute to the effort. The Rice Biotechnology Program is a good example of what can be done, and lessons learned from it could be applied to research in other crops (and livestock and fisheries).

Strengthening the CGIAR's biotechnology capacity would enable it to:

- Be better connected to the cutting-edge research in biotechnology
- Have easier access to and stronger absorptive capacity to use proprietary technology from the private sector
- Build intellectual assets (in the form of protected traits and technologies) that could enable it participate more effectively in the changing global biotechnology market
- Generally expand the developing world's *freedom to operate*.

How quickly the CGIAR *should* expand its biotechnology capacity depends on the advantages biotechnology offers for solving the most urgent research problems, which need to be evaluated on a case-by-case basis. How quickly the CGIAR *could* expand its biotechnology capacity depends on the availability of additional funds—additional, because the effort would involve little or no replacement of existing activities—and on the amount of technology it can access from private companies.

How the CGIAR expands its biotechnology capacity is also important. To the extent possible, it should avoid redundancies in research effort with private companies and advanced research institutions and aim to tap existing technologies in the most efficient way. This requires that the CGIAR strengthen its *connectedness* to others' research in biotechnology, identifying what might be of interest to the solution of research problems the CGIAR is working on, and making arrangements to access that knowledge.

*The CGIAR's position on intellectual property protection.* It is standard practice in the biotechnology research field, among private sector corporations and public sector biotechnology institutes, to obtain patents and licenses to claim exclusive access to products or techniques. Patents and licenses help trace the values added by all contributing parties to an innovation and set the criteria for distribution of benefits. Confidentiality is another norm in all partnerships, most of which are bilateral.

The CGIAR Centers have entered into several confidentiality and licensing agreements and, in the case of ILRI, joint ventures (see Annex 3). Their success indicates that the Centers have found ways to reconcile the public good nature of their work with the proprietary aspects of the private sector biotechnology industry. However, in most of the examples provided, the Centers were merely the recipients of freely provided proprietary technology and used it to generate public goods targeted for use in specific developing countries.

If the CGIAR expands its biotechnology capacity significantly, the Centers will also become producers of technologies of possible value in the biotechnology market. They will then have to



decide if their products should be treated as public goods or should be protected as private goods. There is the option of providing free access to some partners (e.g., developing countries) and conditional access to others (e.g., as trading chips with corporations).

Thus, an increased biotechnology capacity might compel the CGIAR to adopt some of the practices of the private sector, while maintaining its basic orientation as a public goods producer.

## **Conclusions**

There is a compelling case for the CGIAR to strengthen its capacity in biotechnology. However, this should not be at the expense of its existing strengths. Biotechnology should be treated as one of the tools Center researchers can use in conjunction with other powerful tools in developing agricultural technologies needed in poor countries.

In strengthening its biotechnology capacity the CGIAR should avoid “re-inventing the wheel” and aim to access enabling technologies that are available elsewhere. This will require the CGIAR to expand significantly its “technology scouting” effort. In this area, learning from the experiences of some companies could be helpful.

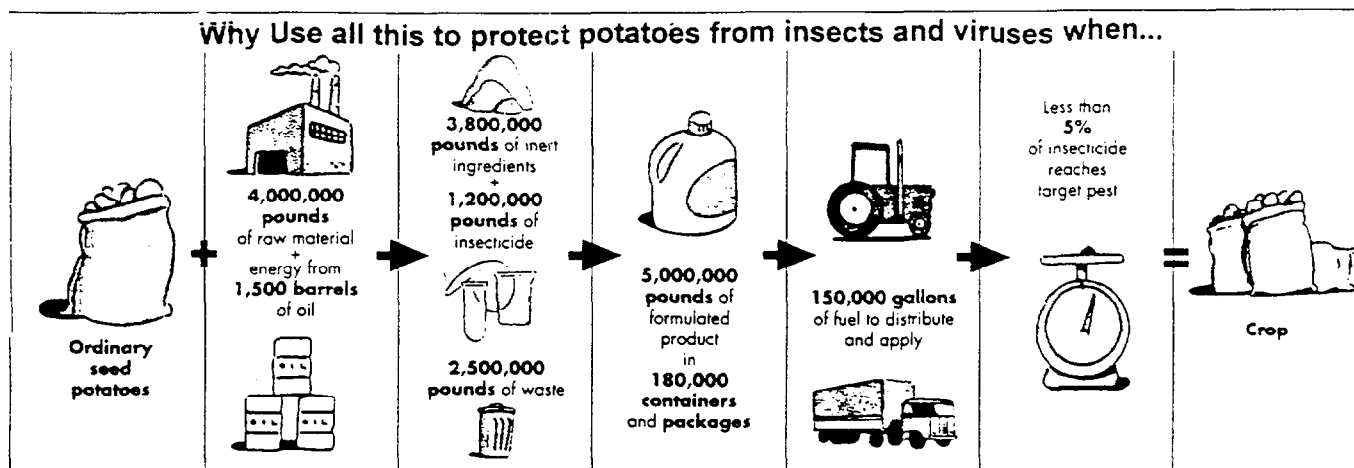
The private sector can assist the CGIAR in this effort also in other ways—ranging from staff and information exchange to collaboration on specific projects. Because many of these projects will be bilateral (i.e., between a CGIAR Center and a corporation), it is important that the CGIAR develop a portfolio of biotechnology projects to bring specificity to potential alliances. It is also important to spell out clearly what the two partners would gain from the partnership.

The CGIAR, despite its global assets and its potential as a viable biotechnology partner, is not widely known within the private sector. The possibility of a major new CGIAR effort in biotechnology presents an opportunity to explore with the leaders of major corporations what can be achieved through partnerships, while raising their awareness about the CGIAR. A high-level conference of private sector leaders, organized by the CGIAR and its cosponsoring agencies, could seek the advice of leading chief executive officers and other corporate officers on ways to expand the CGIAR’s *freedom to operate* in developing technologies targeted toward orphan market segments in these countries. The PSC is prepared to assist in organizing such a conference.

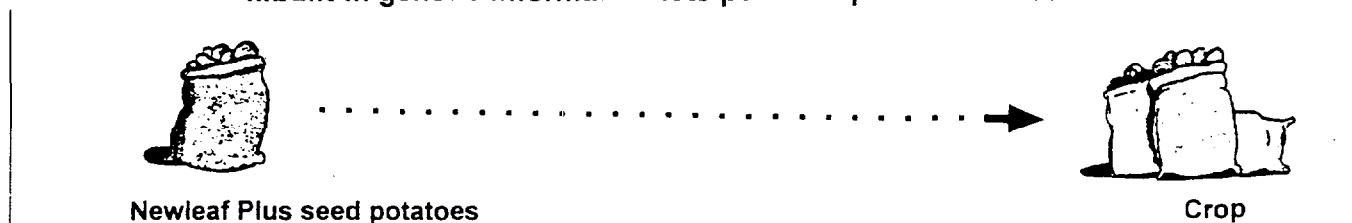
## Annex 1

Excerpt from *Harvard Business Review*\*

### MONSANTO'S SMARTER PRODUCTS



...built-in genetic information lets potatoes protect themselves?



Scientists at Monsanto are designing products that use information at the genetic or molecular level to increase productivity. Here are three that are on the market today.

**The NewLeaf Potato.** The New Leaf potato, bioengineered to defend itself against the destructive Colorado potato beetle, is already in use on farms. Monsanto also is working on the NewLeaf Plus potato with inherent resistance to leaf virus, another common scourge. Widespread adoption of the product could eliminate the manufacture, transportation, distribution, and aerial application of millions of pounds of chemicals and residues yearly.

**B.t. Cotton.** In ordinary soil, microbes known as B.t. microbes occur naturally and produce a special protein that, although toxic to certain pests, are harmless to other insects, wildlife, and people. If the destructive cotton budworm, for example, eats B.t. bacteria, it will die. Some cotton farmers control budworms by applying to their cotton plants a powder containing B.t. But the powder often blows or washes away, and reapplying it is expensive. The alternative is for farmers to spray the field with a chemical insecticide as many as 10 or 12 times per season.

But Monsanto's scientists had an idea. They identified the gene that tells the B.t. bacteria to make the special protein.

Then they inserted the gene in the cotton plant to enable it to produce the protein on its own while remaining unchanged in other respects. Now when budworms attack, they are either repelled or killed by the B.t.

**Roundup Herbicide and No-Till Farming.** Roundup herbicide is a molecule designed to address a major problem for farmers: topsoil erosion. Topsoil is necessary for root systems because of its organic matter, friability in structure, and water-holding capabilities. The subsoil underneath is incapable of supporting root systems. Historically, farmers have tilled their soil primarily for weed control and only to a minor extent for seed preparation. But plowing loosens soil structure and exposes soil to erosion.

By replacing plowing with application of herbicides like Roundup—a practice called *conservation tillage*—farmers end up with better soil quality and less topsoil erosion. When sprayed onto a field before crop planting, Roundup kills the weeds, eliminating the need for plowing. And because the Roundup molecule has been designed to kill only what is growing at the time of its initial application, the farmer can come back a few days after spraying and begin planting; the herbicide will have no effect on the emerging seeds.

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## Annex 2

### Forms of Partnerships

A recent review of literature on strategic alliances<sup>20</sup> noted that the three most common forms of partnerships are licensing arrangements, joint ventures, and consortia.

#### Licensing Arrangements

Licensing arrangements, quite common in the agricultural biotechnology field, enable use of a technology by another entity within the limits specified in the agreement. Licensing its technology allows a company to maintain some control over the flow of that technology through the supply chain. Entering into licensing arrangements with foreign firms enables market expansion—without more costly direct investment in unfamiliar markets. Firms, especially in the pharmaceutical and chemical industries, also enter into cross-licensing arrangements, in which major firms “willingly license their newest technological breakthroughs to one another in order to amortize R&D costs and to promote specialization of different research-based competencies.”<sup>21</sup>

There are disadvantages to licensing, however. For example, a licensee could become a competitor, although this is not an important issue in agreements with public sector licensees. For both public sector and private sector licensees, enforcing the patents and IPR agreements could become an issue, particularly if enforcement must be pursued in the courts of another country.

#### Joint Ventures

Joint ventures involve two or more parties creating a new entity. Each party brings assets to the venture and they share decision-making responsibility. In specialization ventures each partner brings to the venture a different but complementary asset (e.g., one partner provides the trait, the other the seed). In shared value-adding ventures, partners bring similar assets and share responsibilities at each stage of the process (e.g., both conduct research, design products, and then market them jointly).<sup>22</sup>

Joint ventures enable each partner to finance only a part of the cost of an activity. This is an important factor for high-risk and high-cost projects that no single partner would be able to undertake alone (e.g., designing a new video technology). Joint ventures also allow companies to expand their markets, particularly if the partners have competitive advantages in different markets.

The success of a joint venture depends on how well the partners work together. It is critical that all parties clearly understand the others' expectations and commitments and that they continue to learn from each other throughout the venture. If one party dominates the relationship it may lead to a dependency syndrome, which is unhealthy for the future of the relationship.

#### Consortia

Consortia are more complex and loosely coupled forms of partnership than joint ventures; partners build an interorganizational entity to carry out activities in a specific area. Equivalent to consortia are the Japanese *keiretsu* and the South Korean *chaebols*.<sup>23</sup>

Research and development consortia are the most relevant for this report. What differentiates R&D consortia from joint ventures is the fact that the former include direct competitors, while the latter usually do not. The principal reasons for an institution to join a consortium are “to achieve economies of scale, to share the risks involved in an innovation, to set

a standard for a new technology, to share complementary knowledge, and to help protect a 'leaky technology' from being appropriated by companies not sharing in the research efforts."<sup>24</sup>

Consortia are risky for companies if there is any danger of proprietary interests being inadvertently compromised. There is also uncertainty about the behavior of other partners in taking early advantage of the research findings of the consortium. However, if there is a clear strategic advantage for forming a consortium (e.g., because of a threat from a foreign competitor), the interest of the partners might outweigh these disadvantages.

## Annex 3

### Examples of Public-Private Research Partnerships in Biotechnology

Examples of successful partnerships in research on biotechnology between companies in the industrialized countries and public institutions in developing countries and similar examples of collaboration between private firms and CGIAR Centers are presented below.

#### Partnerships with Developing Country Public Sector Institutions

Few developing countries have capacity and experience in research on agricultural biotechnology. Of those that do (e.g., Brazil, China, India, Indonesia, and Thailand), their capacity is more in the public sector than in the private sector, which parallels the early situation in industrialized countries.

As the markets and IPR regimes in developing countries become stronger, corporations in the industrialized countries are becoming increasingly interested in entering those markets. In the interim, technology transfer in biotechnology is being facilitated through a number of international programs, the most prominent of which are the following:

- International Service for the Acquisition of Agribiotech Applications (ISAAA)
- Agricultural Biotechnology for Sustainable Productivity (ABSP) Program based at Michigan State University
- The Rice Biotechnology Program of Rockefeller Foundation
- The Intermediary Biotechnology Service (IBS) based at ISNAR.

Examples of agricultural biotechnology transfer from the private sector to developing countries through some of these intermediary programs are shown in Table 1.

#### Partnerships with CGIAR Centers

One of the first activities of the Private Sector Committee of the CGIAR was to conduct a questionnaire survey of the CGIAR Centers focusing on two key issues: to understand CGIAR Centers' associations with private sector institutions and to assess the potential for future collaboration. The responses and follow-up discussions with Center staff indicated that several Centers have participated in biotechnology research partnerships with corporations from industrialized countries. These are described in the following paragraphs.

The **International Livestock Research Institute (ILRI)** has long-standing cooperative agreements with the pharmaceutical industry whereby the pharmaceutical industry provides ILRI with expertise on vaccine delivery systems, production facilities, and marketing and distribution concerns, and ILRI provides the active research on potential antigens and protective immunity for the development of vaccines to combat tropical diseases in livestock. ILRI has taken steps to patent its research findings in this area to ensure continued cooperation of private sector partners. The patent applies only to the research phase of vaccine development and will not affect the availability of the final product to users in developing countries. Although knowledge and expertise have been transferred to the private sector through collaborative research, the private sector has not yet marketed any final products.

**Table 1. Examples of Agricultural Biotechnology Transfer  
from the Private Sector to Developing Countries**

<b>Technology</b>	<b>Private Sector Collaborator</b>	<b>Developing Country Collaborator</b>	<b>Intermediary Program</b>
Maize transformation with <i>Bacillus thuringiensis</i> (Bt) protein genes, for resistance to Asian stemborer	ICI Seeds (USA)	Central Research Institute for Food Crops (CRIFC, Indonesia)	Agricultural Biotechnology for Sustainable Productivity (ABSP)
Bioreactor technology for micropropagation of banana, pineapple, coffee, and ornamental palms	DNA Plant Technology (USA)	Agribiotecnologia de Costa Rica (ACR)  Fitotek Unggul (Indonesia)	ABSP
Transformation technology for the development of virus-resistant sweet potato	Monsanto (USA)	Kenya Agricultural Research Institute (KARI)	Feathery mottle virus-resistant sweet potato for African farmers
Transformation technology for the development of potatoes resistant to potato virus x and y	Monsanto (USA)	Center for Advanced Research Studies (CINVESTAV, Mexico)	International Service for the Acquisition of Agri-biotech Applications (ISAAA)
Coat-protein technology for the development of melons resistant to cucumber mosaic virus	Asgrow Seed (USA)	Research Center in Cell and Molecular Biology (CIBCM, Costa Rica) CINVESTAV (Mexico)	ISAAA
ELISA kits for local maize viruses	Pioneer Hi-Bred (USA)	National Research Center for Maize and Sorghum (CNPMS, Brazil)	ISAAA

*Source:* Cohen, J. I., and J. Komen. 1995. "Research Collaboration, Management and Technology Transfer: Meeting the Needs of Developing Countries." In D. Altman and K. Watanabe, eds., *Plant Biotechnology Transfer to Developing Countries*, pp. 253–266. San Diego/Austin: Academic Press/RG Landes Company.

The **Centro Internacional de Agricultura Tropical (CIAT)** is actively collaborating with Sandoz Seeds, Ltd. (Switzerland), mediated by ISAAA. Sandoz Seeds has licensed the use of its proprietary "positive selection technology" for use in cassava by CIAT on a non-fee basis and under specified conditions. The IPRs on the technology remain the property of Sandoz Seeds. The technology is to be used only for the transformation of cassava and only in the laboratories of CIAT; licensing for use in other crops or other laboratories will be considered by Sandoz Seeds on a case-by-case basis. CIAT may evaluate and distribute transgenic cassava plants resulting from the use of the technology in any part of the world, providing that the target countries have implemented biosafety regulations and that deliberate release is approved. The agreement

between CIAT and Sandoz Seeds includes a confidentiality clause.

The **International Rice Research Institute (IRRI)** is actively collaborating with several private sector firms in its biotechnology program. Plantech (Japan) and Ciba-Geigy (Switzerland) made two *Bt* genes available to IRRI. The agreements with these companies enable IRRI to "conduct research to improve the function of the genes in rice and ultimately make the products of this research freely available in most developing countries. Under the agreement signed with Plantech, a consortium including IRRI and some other institutions paid a fee to use the *Bt* gene for research purposes only. After the research phase, the consortium has the option to buy the gene outright from Plantech at an already agreed price. Under the agreement signed with Ciba-Geigy, the *Bt* gene was provided to IRRI at no charge. *Bt* rice produced with this gene can be made freely available to rice producers in all countries except Australia, Canada, Japan, New Zealand, United States, and members of the European Patent Convention as of 1994."<sup>25</sup>

The **Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)** has a major biotechnology program and collaborates with private sector institutions on research. It has material transfer agreements with the private sector involving maize trials conducted by private seed companies in developing countries. It also collaborates with the private sector within the Latin American Maize Program (LAMP) for evaluation of maize accessions held in Latin American gene banks.

The **Centro Internacional de la Papa (CIP)** has been collaborating with two companies to develop transgenic potatoes with increased resistance to pests and diseases. "Plant Genetic Systems (PGS) of Belgium has provided genes and technologies to enhance insect pest resistance using *Bt* genes. AXIS Genetics (UK) has provided genes and transgenic potatoes and sweet potatoes using cowpea trypsin inhibitor and snowdrop lectin genes. The results of collaborative research with private companies are freely available for developing countries, provided the recipient will not appropriate them unfairly or seek profit through their commercialization in industrial countries."<sup>26</sup>

The **International Service for National Agricultural Research (ISNAR)** hosts the Intermediary Biotechnology Service (IBS), which assists national agricultural research systems in developing countries with needs-oriented biotechnology program management. Its activities include providing advice on policy formulation, country reviews, and identifying and collecting information on international biotechnology program expertise.

## **Annex 4**

### **CGIAR Private Sector Committee**

#### ***Mission Statement***

*The Private Sector Committee's mission is to provide a private sector perspective to the CGIAR regarding the current status and future needs of global agricultural research. Through its membership the Committee reflects the views of national and international for-profit enterprises of varying scales and with direct interest in agricultural research.*

*The Committee serves as a link between the CGIAR and the private sector at large and aims to forge new alliances for improving food security and the quality of the environment. It helps identify collaborative research opportunities of mutual benefit.*

*The Committee works closely with representatives of other major partners in agricultural research, including the international centers, national research systems, and non-governmental organizations. It also helps raise the awareness of the global community to the opportunities agricultural research provides for creating better livelihoods for present and future generations.*



## Annex 5

### Composition of the CGIAR Private Sector Committee

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## Endnotes

<sup>1</sup> Biotechnology Industry Organization. 1996. *The Transfer of Agricultural Biotechnology to Developing Countries: A Series of Case Studies*.

<sup>2</sup> Fuglie, K., N. Ballenger, K. Day, C. Koltz, M. Ollinger, J. Reilly, U. Vasavada, and J. Yee. 1996. *Agricultural Research and Development: Public and Private Investments Under Alternative Markets and Institutions*. U.S. Department of Agriculture.

<sup>3</sup> Renton, Holling C. "The Year in Products: Biotech 1995, Reform, Restructure, Renewal." Ernst and Young. *Tenth Industry Annual Report on the Biotechnology Industry*, p. 23.

<sup>4</sup> Tasker, Charlotte A., with Ray A. Goldberg. 1996. "Delta & Pine Land: Measuring the Value of Transgenic Cotton." Harvard Business School N0-597-005.

<sup>5</sup> Fuglie, et al.

<sup>6</sup> The term "tropical crops" is used in this paper to refer to crops grown in developing countries, including those grown in arid and semi-arid environments.

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<sup>8</sup> Ibid.

<sup>9</sup> Carter, Mollie H., with Ray A. Goldberg. 1996. "Pioneer Hi-Bred: Testing for Gene Transfers." Harvard Business School. N9-597-055, p. 21.

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<sup>12</sup> Magretta, Joan. 1997. "Growth Through Global Sustainability: An Interview with Monsanto's CEO, Robert B. Shapiro." *Harvard Business Review*. January–February. p. 87.

<sup>13</sup> Kanter, Rosabeth Moss. 1994. "Collaborative Advantages: The Art of Alliances." *Harvard Business Review*. July–August, p. 96.

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<sup>15</sup> Powell, W. W., K. W. Koput, and L. Smith-Doerr. 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly* 41: 116–145.

<sup>16</sup> Ibid.

<sup>17</sup> James, Clive. 1996. *Issues in Agriculture 9: Agricultural Research and Development— The Need for Public-Private Sector Partnerships*. Washington, DC: CGIAR Secretariat, The World Bank.

<sup>18</sup> Bell, D. E., and B. D. Harrison. 1993. "A Review of The Rockefeller Foundation Rice Biotechnology Program."

<sup>19</sup> It is estimated that in 1992 the U.S. private sector spent \$595 million on agricultural biotechnology research, which is 12 percent of the total private sector investment in overall biotechnology R&D. The total U.S. private sector biotechnology research expenditure was \$7.9 billion in 1996. If one assumes that the share of agricultural biotechnology research spending in 1996 was similar to that in 1992, the 1996 private sector agricultural biotechnology research spending would be about \$959 million.

There were about 500 biotechnology firms in Europe in 1996, as compared with 1,300 in the United States. If one were to add to this the number of biotechnology firms in Australia, Canada, Japan, and other non-European OECD countries, the agricultural biotechnology research spending by non-U.S. companies would be about \$500 million, or half the amount spent in the United States. These add to about \$1.5 billion private sector agricultural biotechnology research spending globally (for 1996).

In 1992 agricultural biotechnology research spending by the U.S. federal government (\$188 million) was about 30 percent of that spent by the private sector (\$595 million). If a similar ratio were to apply to other

countries, the total public sector agricultural biotechnology research spending would be about \$0.5 billion in 1996.

Thus, the total agricultural biotechnology research spending in OECD countries is estimated to be about \$2 billion in 1996.

<sup>20</sup> Merrill-Sands, Deborah, and Brigitte Sheridan. 1996. "Developing and Managing Collaborative Alliances: Lessons from a Review of the Literature." Support Program on Organizational Change in the CGIAR Centers. Boston: Simmons Institute for Leadership and Change, Simmons College.

<sup>21</sup> Lei, David, and John W. Slocum, Jr. 1991. "Global Strategic Alliances: Payoffs and Pitfalls." *Organizational Dynamics*. Winter.

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<sup>23</sup> Ibid.

<sup>24</sup> Evan, William M., and Paul Olk. 1990. "R&D Consortia: A New U.S. Organizational Form." *Sloan Management Review*, no. 37, p. 40.

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